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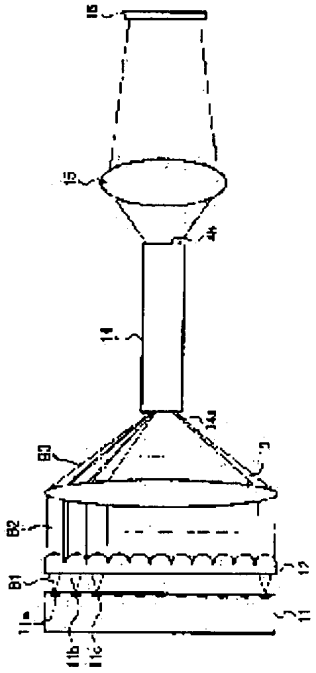
(54) LIGHTING FIXTURE, UNIFORM LIGHTING FIXTURE, PROJECTION DEVICE USING THESE, ALIGNER AND LASER PROCESSING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical system and an optical device using this for uniformly irradiating light emitted from a plurality of light sources realizing a compact constitution to radiate at the minimum angle of incidence.
SOLUTION: In a laser array 11, laser emission parts 11a, 11b, 11c... are straightly arranged at an equal pitch and an outgoing light B1 is made a parallel luminous flux (luminous flux B2) regarding at least one direction by a cylindrical lens array 12. For example, in one embodiment of Fig. 1, the outgoing light B1 is made parallel in a direction parallel to the paper surface. The outgoing luminous flux B3 is converged to an incident side edge surface 14a of a kaleidoscope 14. A distribution of an in-plane strength of the luminous flux is uniformized in the kaleidoscope 14 and is radiated to a part 16 to be irradiated by a relay lens 15.



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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] a luminescence means to have two or more light-emitting parts, and this light-emitting part -- respectively -- since -- let at least each of the diffused light which carries out outgoing radiation be parallel light about the same one direction in the field which intersects perpendicularly with the optical axis of this diffused light -- parallel -- Guanghua -- a means -- this -- parallel -- Guanghua -- the lighting system characterized by having a condensing means to condense two or more flux of lights which carried out outgoing radiation from the means in the condensing predetermined range.
[Claim 2] It is the lighting system characterized by being constituted with the lens with which said YukimitsuTaira-ized means was attached in each light-emitting part of said luminescence means in the lighting system according to claim 1.
[Claim 3] It is the lighting system characterized by for said luminescence means having the laser light-emitting part which emits light in a laser beam in a lighting system according to claim 1 or 2, and being constituted.
[Claim 4] It is the lighting system characterized by constituting said luminescence means in claim 1 thru/or a lighting system given in any 1 of 3 so that said two or more light-emitting parts may carry out an array array in an one direction, and constituting said YukimitsuTaira-ized means so that outgoing radiation light from said two or more light-emitting parts may be formed into Yukimitsu Taira about the direction which is in agreement in said array array direction.
[Claim 5] The lighting system with which the array pitch of each cylindrical-lens section which constitutes this cylindrical-lens array is characterized by being equivalent to the array pitch of said light-emitting part in a lighting system according to claim 4, using a cylindrical-lens array as said YukimitsuTaira-ized means.
[Claim 6] The lighting system characterized by having said at least two or more cylindrical-lens arrays in a lighting system according to claim 5.
[Claim 7] The lighting system with which the array pitch of each micro lens which constitutes this lenticular lens is characterized by being equivalent to the array pitch of said light-emitting part in a lighting system according to claim 4, using a lenticular lens as said YukimitsuTaira-ized means.
[Claim 8] The lighting system characterized by having said at least two or more lenticular lenses in a lighting system according to claim 7.
[Claim 9] The homogeneity lighting system characterized by having an intensity-distribution equalization means for making the optical intensity distribution within the field which receives the illumination light which carried out outgoing radiation to claim 1 thru/or any 1 of 8 from the lighting system and this lighting system of a publication, and intersects perpendicularly with the optical axis of the light which this received light equalize, controlling the outgoing radiation light from this intensity-distribution equalization means, and illuminating the candidate for lighting.
[Claim 10] The homogeneity lighting system characterized by using a kaleidoscope as said intensity-distribution equalization means in a homogeneity lighting system according to claim 9.
[Claim 11] The homogeneity lighting system characterized by using a homogenizer as said intensity-distribution equalization means in a homogeneity lighting system according to claim 9.

[Claim 12] The homogeneity lighting system characterized by using a fly eye lens as said intensity-distribution equalization means in a homogeneity lighting system according to claim 9.
[Claim 13] In the array array direction of the laser array in which two or more laser light-emitting parts come to carry out an array array, and this laser array And the cylindrical-lens array in which a cylindrical lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The kaleidoscope for making the intensity distribution of the flux of light which carried out outgoing radiation from this cylindrical lens equalize, It is illumination-light study equipment which has the relay lens which controls the optical path of the outgoing radiation light from this kaleidoscope, and illuminates the candidate for lighting. Said cylindrical-lens array The homogeneity lighting system characterized by being constituted so that the outgoing radiation light which acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and carries out outgoing radiation of this cylindrical-lens array may become in the direction of an array of said cylindrical lens with Yukimitsu Taira.
[Claim 14] In the array array direction of the laser array in which two or more laser light-emitting parts come to carry out an array array, and this laser array, and the lenticular lens in which a micro lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The kaleidoscope for making the intensity distribution of the flux of light which carried out outgoing radiation from this lenticular lens equalize, It is illumination-light study equipment which has the relay lens which controls the optical path of the outgoing radiation light from this kaleidoscope, and illuminates the candidate for lighting. Said lenticular lens The homogeneity lighting system characterized by being constituted so that the outgoing radiation light which acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and carries out outgoing radiation of this lenticular lens may become in the direction of an array of this lenticular lens with Yukimitsu Taira.
[Claim 15] In the array array direction of the laser array in which two or more laser light-emitting parts come to carry out an array array, and this laser array And the resillin DORIKARU lens array in which a cylindrical lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The homogenizer for making the intensity distribution of the flux of light which carried out outgoing radiation from this cylindrical-lens array equalize, It is illumination-light study equipment which has the relay lens which controls the optical path of the outgoing radiation light from this homogenizer, and illuminates the candidate for lighting. Said cylindrical-lens array The homogeneity lighting system characterized by being constituted so that the outgoing radiation light which acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and carries out outgoing radiation of this cylindrical-lens array may become in the direction of an array of this cylindrical-lens array with Yukimitsu Taira.
[Claim 16] In the array array direction of the laser array in which two or more laser light-emitting parts come to carry out an array array, and this laser array, and the lenticular lens in which a micro lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The homogenizer for making the intensity distribution of the flux of light which carried out outgoing radiation from this lenticular lens equalize, It is illumination-light study equipment which has the relay lens which controls the optical path of the outgoing radiation light from this homogenizer, and illuminates the candidate for lighting. Said lenticular lens The homogeneity lighting system characterized by being constituted so that the outgoing radiation light which acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and carries out outgoing radiation of this lenticular lens may become in the direction of an array of this lenticular lens with Yukimitsu Taira.
[Claim 17] In the array array direction of the laser array in which two or more laser light-emitting parts come to carry out an array array, and this laser array And the resillin DORIKARU lens array in which a cylindrical lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The fly eye lens for making the intensity distribution of the flux of light which carried out outgoing radiation from this cylindrical-lens array equalize, It is illumination-light study equipment which illuminates the candidate for lighting

by the outgoing radiation light from this fly eye lens. Said cylindrical-lens array The homogeneity lighting system characterized by being constituted so that the outgoing radiation light which acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and carries out outgoing radiation of this cylindrical-lens array may become in the direction of an array of this cylindrical-lens array with Yukimitsu Taira.

[Claim 18] In the array array direction of the laser array in which two or more laser light-emitting parts come to carry out an array array, and this laser array, and the lenticular lens in which a micro lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The fly eye lens for making the intensity distribution of the flux of light which carried out outgoing radiation from this lenticular lens equalize, It is illumination-light study equipment which controls the optical path of the outgoing radiation light from this fly eye lens, and illuminates the candidate for lighting. Said lenticular lens The homogeneity lighting system characterized by being constituted so that the outgoing radiation light which acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and carries out outgoing radiation of this lenticular lens may become in the direction of an array of this lenticular lens with Yukimitsu Taira.

[Claim 19] The homogeneity lighting system characterized by equipping any 1 of claims 13, 15, and 17 with said at least two or more cylindrical-lens arrays in the homogeneity lighting system of a publication.

[Claim 20] The homogeneity lighting system characterized by equipping any 1 of claims 14, 16, and 18 with said at least two or more lenticular lens arrays in the homogeneity lighting system of a publication.

[Claim 21] The projection device characterized by having at least the projector lens which projects the light which carried out outgoing radiation in claim 9 thru/or any 1 of 20, and a light valve illuminated by the homogeneity lighting system and this homogeneity lighting system of a publication and this light valve being consisted of.

[Claim 22] The aligner characterized by having the homogeneity lighting system, reticle, and projection lens of a publication in claim 9 using the laser array as said luminescence means thru/or any 1 of 20, and being constituted.

[Claim 23] The laser beam machine characterized by having the homogeneity lighting system of a publication, and a lens for condensing in claim 9 using the laser array as said luminescence means thru/or any 1 of 20, and being constituted.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] More specifically, this invention relates to the technique which can apply this light source light to the irradiated section about equipment applicable to the optical system which carries out homogeneity lighting at a projection device (projector), a stepper (aligner), etc. about the projection device which used illumination-light study equipment, an illumination-light study method, and these, an aligner, and laser-beam-machining equipment by making into the light source two or more luminescence means depended on laser array light etc.
[0002]
[Description of the Prior Art] The optical system for illuminating the irradiated section for an exposure to homogeneity is not only suitable for the light which used for example, the liquid crystal display component, the stepper used for the projection device of a bulb method, manufacture of a semi-conductor, etc., but application for various applications is possible and high degree of accuracy and the optical system of a compact and simple configuration are searched for. Moreover, an illumination-light study system is wanted to be set up, for example so that whenever [over a light valve / maximum angle-of-incidence] may become as small as possible in the projection device of the above-mentioned light valve method (that is, incidence is carried out to the front face of a light valve as perpendicularly as possible like).
[0003]
[Problem(s) to be Solved by the Invention] the light emitted from these two or more light sources using the luminescence unit by two or more light sources which this invention was made in view of the actual condition like ****, and realize a compact configuration -- an irradiated plane -- receiving -- homogeneity -- moreover, it aims at offering the lighting system for carrying out an irradiated plane pair and irradiating by the minimum incident angle and the projection device using this, an aligner, and a laser beam machine.
[0004]
[Means for Solving the Problem] a luminescence means by which invention of claim 1 has two or more light-emitting parts, and this light-emitting part -- respectively -- since -- let at least each of the diffused light which carries out outgoing radiation be parallel light about the same one direction in the field which intersects perpendicularly with the optical axis of this diffused light -- parallel -- Guanghua -- a means -- this -- parallel -- Guanghua -- it is characterized by having a condensing means to condense two or more flux of lights which carried out outgoing radiation from the means in the condensing predetermined range.
[0005] Invention of claim 2 is characterized by constituting said YukimitsuTaira-ized means with the lens attached in each light-emitting part of said luminescence means in invention of claim 1.
[0006] Invention of claim 3 is characterized by for said luminescence means having the laser light-emitting part which emits light in a laser beam, and constituting it in invention of claims 1 or 2.
[0007] It is characterized by constituting said luminescence means so that said two or more light-emitting parts may carry out the array array of the invention of claim 4 in claim 1 thru/or invention of any one of 3 in an one direction, and constituting said YukimitsuTaira-ized means so

that outgoing radiation light from said two or more light-emitting parts may be formed into Yukimitsu Taira about the direction which is in agreement in said array array direction.
[0008] It is characterized by invention of claim 5 having the array pitch of each cylindrical-lens section which constitutes this cylindrical-lens array in invention of claim 4, using a cylindrical-lens array as said YukimitsuTaira-ized means equivalent to the array pitch of said light-emitting part.
[0009] Invention of claim 6 is characterized by having said at least two or more cylindrical-lens arrays in invention of claim 5.
[0010] It is characterized by invention of claim 7 having the array pitch of each micro lens which constitutes this lenticular lens in invention of claim 4, using a lenticular lens as said YukimitsuTaira-ized means equivalent to the array pitch of said light-emitting part.
[0011] Invention of claim 8 is characterized by having said at least two or more lenticular lenses in invention of claim 7.
[0012] Invention of claim 9 is characterized by having an intensity-distribution equalization means for making the optical intensity distribution within the field which receives the illumination light which carried out outgoing radiation from claim 1 thru/or any 1 lighting system of 8, and this lighting system, and intersects perpendicularly with the optical axis of the light which this received light equalize, controlling the outgoing radiation light from this intensity-distribution equalization means, and illuminating the candidate for lighting.
[0013] Invention of claim 10 is characterized by using a kaleidoscope as said intensity-distribution equalization means in invention of claim 9.
[0014] Invention of claim 11 is characterized by using a homogenizer as said intensity-distribution equalization means in invention of claim 9.
[0015] Invention of claim 12 is characterized by using a fly eye lens as said intensity-distribution equalization means in invention of claim 9.
[0016] The laser array to which two or more laser light-emitting parts come to carry out the array array of the invention of claim 13, In the array array direction of this laser array, and the cylindrical-lens array in which a cylindrical lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The kaleidoscope for making the intensity distribution of the flux of light which carried out outgoing radiation from this cylindrical lens equalize, It is illumination-light study equipment which has the relay lens which controls the optical path of the outgoing radiation light from this kaleidoscope, and illuminates the candidate for lighting. Said cylindrical-lens array It acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and is characterized by being constituted so that the outgoing radiation light which carries out outgoing radiation of this cylindrical-lens array may become in the direction of an array of said cylindrical lens with Yukimitsu Taira.
[0017] The laser array to which two or more laser light-emitting parts come to carry out the array array of the invention of claim 14, In the array array direction of this laser array, and the lenticular lens in which a micro lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The kaleidoscope for making the intensity distribution of the flux of light which carried out outgoing radiation from this lenticular lens equalize, It is illumination-light study equipment which has the relay lens which controls the optical path of the outgoing radiation light from this kaleidoscope, and illuminates the candidate for lighting. Said lenticular lens It acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and is characterized by being constituted so that the outgoing radiation light which carries out outgoing radiation of this lenticular lens may become in the direction of an array of this lenticular lens with Yukimitsu Taira.
[0018] The laser array to which two or more laser light-emitting parts come to carry out the array array of the invention of claim 15, In the array array direction of this laser array, and the resillin DORIKARU lens array in which a cylindrical lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The homogenizer for making the intensity distribution of the flux of light which carried out outgoing radiation from this cylindrical-lens array equalize, It is illumination-light study equipment which has the relay lens

which controls the optical path of the outgoing radiation light from this homogenizer, and illuminates the candidate for lighting. Said cylindrical-lens array It acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and is characterized by being constituted so that the outgoing radiation light which carries out outgoing radiation of this cylindrical-lens array may become in the direction of an array of this cylindrical-lens array with Yukimitsu Taira.

[0019] The laser array to which two or more laser light-emitting parts come to carry out the array array of the invention of claim 16, In the array array direction of this laser array, and the lenticular lens in which a micro lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The homogenizer for making the intensity distribution of the flux of light which carried out outgoing radiation from this lenticular lens equalize, It is illumination-light study equipment which has the relay lens which controls the optical path of the outgoing radiation light from this homogenizer, and illuminates the candidate for lighting. Said lenticular lens It acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and is characterized by being constituted so that the outgoing radiation light which carries out outgoing radiation of this lenticular lens may become in the direction of an array of this lenticular lens with Yukimitsu Taira.

[0020] The laser array to which two or more laser light-emitting parts come to carry out the array array of the invention of claim 17, In the array array direction of this laser array, and the resillin DORIKARU lens array in which a cylindrical lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The fly eye lens for making the intensity distribution of the flux of light which carried out outgoing radiation from this cylindrical-lens array equalize, It is illumination-light study equipment which illuminates the candidate for lighting by the outgoing radiation light from this fly eye lens. Said cylindrical-lens array It acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and is characterized by being constituted so that the outgoing radiation light which carries out outgoing radiation of this cylindrical-lens array may become in the direction of an array of this cylindrical-lens array with Yukimitsu Taira.

[0021] The laser array to which two or more laser light-emitting parts come to carry out the array array of the invention of claim 18, In the array array direction of this laser array, and the lenticular lens in which a micro lens comes to carry out an array array in an array pitch equivalent to the array pitch of said laser light-emitting part, The fly eye lens for making the intensity distribution of the flux of light which carried out outgoing radiation from this lenticular lens equalize, It is illumination-light study equipment which controls the optical path of the outgoing radiation light from this fly eye lens, and illuminates the candidate for lighting. Said lenticular lens It acts on the diffused light which carried out outgoing radiation from said each laser light-emitting part, and is characterized by being constituted so that the outgoing radiation light which carries out outgoing radiation of this lenticular lens may become in the direction of an array of this lenticular lens with Yukimitsu Taira.

[0022] Invention of claim 19 is characterized by having said at least two or more cylindrical-lens arrays in invention of any one of claims 13, 15, and 17.

[0023] Invention of claim 20 is characterized by having said at least two or more lenticular lens arrays in invention of any one of claims 14, 16, and 18.

[0024] Invention of claim 21 is characterized by having at least the projector lens which projects the light which carried out outgoing radiation, and consisting of a light valve illuminated by claim 9 thru/or invention of any one of 20, and this homogeneity lighting system, and this light valve.

[0025] Invention of claim 22 is characterized by having the homogeneity lighting system, reticle, and projection lens of a publication, and being constituted, and carries out it to claim 9 which used the laser array as said luminescence means thru/or any 1 of 20.

[0026] Invention of claim 23 is characterized by having the homogeneity lighting system of a publication, and a lens for condensing in claim 9 which used the laser array as said luminescence means thru/or any 1 of 20, and being constituted.

[0027]

[Embodiment of the Invention] It explains below, referring to a drawing about the indispensable

configuration of this invention first. In addition, about the configuration of an example, it mentions later concretely with reference to a drawing again separately. A luminescence means 11 by which the lighting system of this invention has two or more light-emitting parts 11a, 11b, and 11c, The YukimitsuTaira-ized means 12 which makes Yukimitsu Taira each of the diffused light which carries out outgoing radiation from each of the above-mentioned light-emitting parts 11a, 11b, and 11c at least about the same one direction in the field which intersects perpendicularly with the optical axis of this diffused light, It has a condensing means 13 (31, 32, 33) ((41) (51)) to condense two or more flux of lights which carried out outgoing radiation from the YukimitsuTaira-ized means 12 in the condensing predetermined range. moreover, parallel in the above-mentioned lighting system -- Guanghua -- lens 12a attached in each light-emitting part 11a of a luminescence means as shown in drawing 13 may constitute a means 12. Moreover, the above-mentioned luminescence means 11 can constitute a laser beam with the laser light-emitting parts 11a, 11b, and 11c which emit light.

[0028] moreover, the above-mentioned luminescence means is constituted so that two or more light-emitting parts 11a, 11b, and 11c may carry out an array array in an one direction, and it is parallel -- Guanghua -- a means 12 is constituted so that outgoing radiation light from two or more above-mentioned light-emitting parts may be formed into Yukimitsu Taira about the direction which is in agreement in said array array direction. Moreover, the array pitch of each cylindrical-lens section which constitutes the cylindrical-lens array carries out the EQC of the array pitch of said light-emitting part, using a cylindrical-lens array as the above-mentioned YukimitsuTaira-ized means 12. Moreover, you may have these at least two or more cylindrical-lens arrays.

[0029] Moreover, the array pitch of each micro lens which constitutes this lenticular lens is made equivalent to the array pitch of the above-mentioned light-emitting part, using a lenticular lens as the above-mentioned YukimitsuTaira-ized means 11. Moreover, you may have these at least two or more lenticular lenses.

[0030] Like the above, the homogeneity lighting system of this invention receives the illumination light which carried out outgoing radiation from a lighting system and its lighting system, has the intensity-distribution equalization means 14 (42 43) ((52 53)) for making the optical intensity distribution within the field which intersects perpendicularly with the optical axis of the light which received light equalize, controls the outgoing radiation light from the intensity-distribution equalization means 14, and illuminates the candidate for lighting.

[0031] (Example 1) Drawing 1 and drawing 2 are drawings for explaining the 1st one example of this invention, a side-face outline configuration is shown for the top-face outline configuration of an illumination-light study system in drawing 1 with an optical path at drawing 2 , respectively, and, for a cylindrical-lens array and 13, as for a kaleidoscope and 15, a condensing lens and 14 are [11 / a laser array and 12 / a relay lens and 16] the irradiated sections in drawing 1 and drawing 2 . As for the laser array 11, the laser light-emitting parts 11a and 11b and 11c-- are arranged in pitches [shape / of a straight line]. Outgoing radiation of each outgoing radiation light B1 from each laser light-emitting part is carried out as the diffused light. Such outgoing radiation light B1 is made to form into a Yukimitsu Taira bundle about the one direction by the cylindrical-lens array 12. In the example of drawing 1 , outgoing radiation of the cylindrical-lens array 12 is carried out as flux of light B-2 which made the flux of light which carried out incidence make it parallel in a direction parallel to space. Yukimitsu Taira bundle B-2 in this case may not be strictly parallel. It is good if the flux of lights which adjoin each other with the following condensing lens 13 are not mixed by big angular difference. That is, it will not become a problem, if angular difference is small even if outgoing-beam B-2 has lapped to some extent.

[0032] And with a condensing lens 13, the outgoing beam B3 is converged on incidence side edge side 14a of a kaleidoscope 14. And the flux of light which advances the inside of a kaleidoscope 14 is reflected multiply within a kaleidoscope 14, and distribution of the reinforcement within a field of the flux of light is equalized in the outgoing radiation end-face 14b. The flux of light which has these equalized intensity distribution is irradiated by the relay lens 15 to the irradiated section 16.

[0033] The cylindrical-lens array 12 may be transposed to the so-called lenticular lens. The

cylindrical-lens array 12 is a lens array which has an array pitch comparable as the array pitch of the laser array 11, and should just have lens power to the array direction of a laser array. Also when using a lenticular lens, it constitutes so that the array pitch of the micro lens may be similarly made into the array pitch and EQC of the laser array 11 and it may act similarly. By placing the cylindrical-lens array 12 (or lenticular lens) on the optical path just behind the laser array 11, the installation tolerance of the space thickness direction becomes large by drawing 1 compared with the case where the cylindrical-lens array 11 is transposed to the lens array (it has two-dimensional power) arranged in the shape of a straight line. Namely, what is necessary is to perform only fine tuning of the vertical direction of drawing 1 .

[0034] By using the cylindrical-lens array (or lenticular lens) 12 explains that the maximum incident angle to the irradiated section 16 can be made small using a ray-tracing count result. Drawing 3 is drawing for explaining the effectiveness of the illumination-light study system which used the lenticular lens, and the outline configuration of an illumination-light study system is shown in drawing 3 (A), and it shows the enlarged drawing of the B section of drawing 3 (A) to drawing 3 (B).

[0035] In the configuration shown in drawing 3 , although a laser array including the light sources 11a and 11c as shown in drawing 1 in fact is arranged, in order to explain a characteristic optical path, the whole laser array 11 is omitting the illustration. That is, light source 11a currently illustrated is located in the edge of a laser array, 11n of light sources is located at the core of the laser array 11, and the light source which constitutes other laser arrays is omitting illustration. Just behind light source 11a of laser, the cylindrical-lens array (or lenticular lens) 12 is arranged. It is the one lens section (cylindrical lens) from which 12a constitutes the cylindrical-lens array 12 in drawing 3 (B), and is light source 11a. -- It is array-ized in the direction of y like 11n.

[0036] The light source array pitch of the laser array 11 and the array pitch (or array pitch of the micro lens of a lenticular lens) of each lens of the cylindrical-lens array 12 are these pitches, and show only one micro-lens 12a which constitutes the lenticular section (lenticular lens) corresponding to light source 11a from drawing 3 (B). With the lenticular lens 12, outgoing radiation light from each laser array is made parallel in the direction parallel to space. With this lenticular lens 12, although outgoing radiation light is not completely collimated for the spherical aberration of a lens, effectiveness is enough acquired by a certain amount of Yukimitsu Taira bundle-ization. Beam B-2 formed into the Yukimitsu Taira bundle passes cylindrical lenses 21, 22, and 23, and reaches incidence side edge side 14a of a kaleidoscope 14. In this case, the maximum incident angle to incidence side edge side 14a is 12 degrees.

[0037] A cylindrical lens 21 carries out ******** which makes incidence side edge side 14a of a kaleidoscope 14 deflect laser array light. Cylindrical lenses 22 and 23 carry out ******** which makes the emission beam of the thickness direction (the space thickness direction) of a laser array converge on incidence side edge side 14a.

[0038] (Example of a comparison) Drawing 4 is drawing for explaining the operation in optical system in case there is no lenticular lens 12 in the configuration of above-mentioned drawing 3 . The beam of light at the time of deleting the cylindrical-lens array 12 just behind light source 11a located in the edge of a laser array in the optical system of drawing 3 is shown in drawing 4 . The emission light B11 from light source 11a passes cylindrical lenses 21, 22, and 23, and is irradiated by incidence side edge side 14a of a kaleidoscope 14 at the 16 degrees of the maximum incident angles. Since whenever [incident angle] is maintained, outgoing radiation of the outgoing radiation light from the outgoing radiation side edge side (not shown) of a kaleidoscope 14 is carried out at the 16 degrees of the maximum angles. If drawing 4 is furthermore compared with drawing 3 , the way which used the cylindrical-lens array 12 is able to make aperture of a kaleidoscope 14 small. An overall length also becomes short, so that aperture is small, if it is the kaleidoscope of the same count of reflection. Therefore, an illumination-light study system can be made small by using a cylindrical-lens array (or lenticular lens).

[0039] (Example 2) Drawing 5 and drawing 6 are drawings for explaining the 2nd example of this invention, in the top-face outline configuration of an illumination-light study system, a side-face

outline configuration is shown in drawing 5 with an optical path at drawing 6 , respectively, an illumination-light study system consists of the lens array 11, the cylindrical-lens array 12, a kaleidoscope 14, a relay lens 15, and cylindrical lenses 31, 32, and 33, and 16 is the irradiated section. In addition, the cylindrical-lens array 12 may be transposed to a lenticular lens like an example 1. At this time, the direction of an array and array pitch of a micro lens of a lenticular lens shall presuppose that it is the same as that of the array configuration of a cylindrical lens, and both shall be constituted so that it may act similarly. This example explains as an example which used the cylindrical-lens array 12.

[0040] The cylindrical side is formed in the pitch comparable as the array pitch of the laser array 11, and the cylindrical-lens array 12 has lens power in the direction of an array of the laser array 11, as shown in drawing 5 . Each laser array light B1 emitted by emitting by the cylindrical-lens array 12 is respectively formed into a Yukimitsu Taira bundle only in the direction of an array. In this case, Yukimitsu Taira bundle B-2 obtained may not be strictly parallel. That is, it is not a problem, if angular difference is small even if it is good and has lapped to some extent, if the incoming beams which adjoin each other by the following cylindrical lens 31 are not mixed by big angular difference.

[0041] On the optical path between the cylindrical-lens array 12 and a kaleidoscope 14, at least two or more cylindrical lenses are arranged. Drawing 5 and drawing 6 show the example (cylindrical lenses 31, 32, and 33) by which the cylindrical lens was constituted from three sheets. In this case, the cylindrical lens 32 of one sheet which has power in the direction of an array of the laser array 11, and the cylindrical lenses 31 and 33 of two sheets which have lens power in the rectangular direction of the direction of an array of a laser array are allotted.

[0042] An operation of these cylindrical lenses 31, 32, and 33 is explained. Since it can consider that cylindrical lenses 31 and 33 are the same as an parallel plate about the flux of light of the direction of an array of the laser array 11 as first shown in drawing 5 , beam B-2 by which only the direction of an array was formed into the Yukimitsu Taira bundle penetrates a cylindrical lens 31 as it is, considers as the flux of light B21, and carries out incidence to a cylindrical lens 32. And the incoming beams B21 are deflected by the cylindrical lens 32 (flux of light B22), pass a cylindrical lens 33, and reach incidence side edge side 14a of a kaleidoscope (flux of light B23) 14.

[0043] next, as shown in drawing 6 , about the beam of the direction of an array in the laser array 11, and the rectangular direction Since it can consider that the cylindrical-lens array 12 is monotonous in parallel, the flux of light B1 emitted from each laser light-emitting part Emit, even after penetrating the cylindrical-lens array 12, and it becomes flux of light B-2. It is made parallel by the cylindrical lens 31 (flux of light B21), a cylindrical lens 32 is passed (flux of light B22), and it converges on a kaleidoscope 14 by the cylindrical lens 33 (flux of light B23). The flux of lights B21 and B22 do not need to be Yukimitsu Taira bundles in the vertical direction (namely, the direction of an array and the rectangular direction of a laser array) of drawing 6 . Therefore, cylindrical lenses 31 and 33 are transposed to the cylindrical lens of one sheet, and even if it converges on a kaleidoscope with the one lens, the effectiveness of this invention is not affected.

[0044] (Example 3) Drawing 7 and drawing 8 are drawings for explaining the 3rd example of this invention, in the top-face outline configuration of an illumination-light study system, a side-face outline configuration is shown in drawing 7 with an optical path at drawing 8 , respectively, and an illumination-light study system consists of the laser array 11, the cylindrical-lens array (or lenticular lens) 12, a cylindrical lens 41, homogenizers 42 and 43, and cylindrical lenses 44 and 45. Drawing 16 is the plan (drawing 16 (A)) and side elevation (drawing 16 (B)) showing the configuration of the laser radiation equipment indicated by JP,9-234579,A which used the above-mentioned homogenizer, and this is equipment which raises homogeneity and irradiates a linear laser beam as a linear beam at the irradiated section. This example makes the irradiated rectangle-like section carry out homogeneity lighting of the laser array light using the homogenizers 40a and 40b used in this optical system.

[0045] Since an operation of the cylindrical-lens array 12 (or lenticular lens in which the replacement to this is possible) is as above-mentioned, it omits the explanation. A cylindrical

lens 41 makes the emission beam component of the vertical direction of an array of drawing 8 , i.e., the direction of the laser array 11, and the rectangular direction form into a Yukimitsu Taira bundle (flux of light B31). A homogenizer 42 makes the flux of light of the direction of an array of the laser array 11 equalize. Although the homogenizer 42 of this example has the configuration of 5 division, the flux of light is equalized, so that there is much number of partitions. However, the effectiveness of a homogenizer is not acquired when the incident light to each lens array of a homogenizer 42 serves as the same intensity distribution in drawing 7 . For example, when the array pitch of the lenticular lens 12 and a homogenizer 42 serves as relation of an integral multiple, such a phenomenon arises. The light (flux of lights B32 and B33) from a homogenizer 42 is brought together in the irradiated section 16 by the cylindrical lens 44 (flux of light B34).

[0046] On the other hand, in the flux of light of the direction of an array of the laser array 11, and the rectangular direction, as shown in drawing 8 , the intensity distribution of the flux of light are equalized by the homogenizer 43. That is, the diffused-light component which carried out incidence to the cylindrical lens 41 is formed into a Yukimitsu Taira bundle (flux of light B31), the flux of light is divided by the homogenizer 43, and each of the divided flux of light is made to condense, after connecting a focus, it becomes emission light further (flux of light B33), and it piles up on the irradiated section 16 by the cylindrical lens 45 (flux of light B34). Its effectiveness of equalization is so high that the homogenizer 43 which performs flux of light control of the direction of an array of the laser array 11 and the rectangular direction has much the number of partitions.

[0047] By arranging the cylindrical-lens array (lenticular lens) 12 immediately after the laser array 11,-izing of each array light of the direction of an array can be carried out [a Yukimitsu Taira bundle], and the effectiveness of a homogenizer can be acquired. Moreover, since it is a cylindrical-lens array (or lenticular lens), there is a merit that installation precision is not required, about the direction of an eye and the rectangular direction of a laser array.

[0048] (Example 4) Drawing 9 and drawing 10 are drawings for explaining the 4th example of this invention, in the top-face outline configuration of an illumination-light study system, a side-face outline configuration is shown in drawing 9 with an optical path at drawing 10 , respectively, and an illumination-light study system consists of the laser array 11, the cylindrical-lens array (or lenticular lens) 12, a cylindrical lens 51, fly eye lenses 52 and 53, and a condensing lens 54. In illustrated this example, although the fly eye lenses 52 and 53 of two sheets are used, the fly eye lens 53 of the 2nd sheet is not necessarily required, and can be omitted. Moreover, a condensing lens 54 may transpose the cylindrical lens of two sheets to the thing which made each direction of lens power intersect perpendicularly. In addition, also in this example, a cylindrical-lens array can be transposed to the lenticular lens which has the same function like each above-mentioned example.

[0049] First, with reference to drawing 9 , the operation about a part for Mitsunari of the direction of an array is explained. The cylindrical-lens array 12 has an array pitch comparable as the array pitch of the laser array 11. An operation is as above-mentioned. The beam of the direction of an array of a laser array serves as almost parallel flux of light B-2 by the cylindrical-lens array 12, a cylindrical lens 51 is passed (flux of light B41), and the outgoing beam from each array light source is condensed by the 1st fly eye lens 52 (flux of light B42). The 2nd fly eye lens 53 is arranged in the focal location of the 1st fly eye lens 52. If the travelling direction in the space of drawing 9 of a beam of light which passed the cylindrical-lens array 12 is parallel to the shaft of the 1st fly eye lens 52, it is not required for the 2nd fly eye lens 53. Moreover, the flux of light B41 inclines slightly to the 1st fly eye lens 52 by the case where the outgoing beam B1 from the laser array 11 cannot regard it as the outgoing beam from the point light source, the aberration of the cylindrical-lens array 12, the pitch gap with the laser array 11 in a cylindrical lens 12, etc. In such a case, the beams of light condensed from each lens section which constitutes the 1st fly eye lens 52 need the 2nd fly eye lens 53 in order not to gather for one point. And the outgoing beam from the 2nd fly eye lens 53 is put on the irradiated section 16 with a condensing lens 54 (flux of light B43).

[0050] Next, the operation about the flux of light component of the rectangular direction of the direction of an array of a laser array is explained using drawing 10 . The outgoing beam B1 from

the laser array 11 passes the cylindrical-lens array 12, serves as flux of light B-2, and is made into the Yukimitsu Taira bundle B41 by the cylindrical lens 51. The 2nd fly eye lens 53 is allotted to the focal distance location of the 1st fly eye lens 52 as mentioned above, each lens section of the 2nd fly eye lens 53 is passed, with a condensing lens 54, the outgoing beam (flux of light B42) from each lens section of the 1st fly eye lens 52 puts on the irradiated section 16, is put together, and illuminance equalization is carried out (flux of light B43).

[0051] When the thickness (thickness of the direction of an array and the rectangular direction) of the light-emitting part of the laser array 11 is large, the beams of light with which parallel do not become but the flux of light B41 is not necessarily condensed from each array to the optical axis of the 1st fly eye lens 52 do not gather for one point. For this reason, the 2nd fly eye lens 53 will be used. When it can be considered that the above-mentioned thickness of the light-emitting part of a laser array is sufficiently small, since it is condensed by about one point, the outgoing beam (flux of light B42) from each lens section of the 1st fly eye lens 52 does not need the 2nd fly eye lens 53. By using the cylindrical-lens array 12, there is a merit that installation permission of the above-mentioned thickness direction of the laser array 11 becomes large.

[0052] (Example 5) Drawing 11 is drawing showing the outline configuration of one example of the projection device by this invention with an optical path, and a projection device is equipped with one from the above-mentioned example 1 to an example 4 of illumination-light study systems, and a light valve and a projector lens. The projection device of the example of a configuration shown in drawing 11 is constituted by the illumination-light study systems 61r, 61g, and 61b, the color composition component 62, a light valve 65, and the projector lens 64. Although the optical system of an example 3 is used with the configuration shown in drawing 11 as illumination-light study systems 61r, 61g, and 61b, which optical system from an example 1 to an example 4 may be used as an illumination-light study system as mentioned above.

[0053] As a color composition component 62, a dichroic prism can be used, for example. When the illumination-light study systems 61r, 61g, and 61b are red and the green and blue laser array light source in order, as for the color composition component (dichroic prism) 62, they reflect red by die clo IKKU film 62r, and reflect blue by die clo IKKU film 62b, and both die clo IKKU film 62r and 62b is constituted so that green may be made to penetrate. A liquid crystal device can be used as a light valve 65. With the configuration of drawing 11 , the field lens 63 is used just before the light valve. the light which penetrated the light valve 65 -- the pupil of a projector lens 64 -- it can pass -- ****** is carried out.

[0054] Since the maximum incident angle of the light which illuminates a light valve 65 is reduced by the above configuration as compared with the former as above-mentioned, when it is the light valve from which a contrast ratio changes with incident angles like especially a liquid crystal device, a contrast ratio can be raised or color nonuniformity and illuminance nonuniformity can be reduced.

[0055] light valve of a total of three sheets 65r corresponding to [although drawing 11 showed the example of a configuration which used the light valve of the veneer as it was shown in drawing 12] the illumination-light study systems 61r, 61g, and 61b -- 65g may be 65b used and you may constitute. The field lenses 63r, 63g, and 63b are placed just before each light valves 65r, 65g, and 65b. Since the optical path length between a projector lens 64 and light valves 65r, 65g, and 65b becomes long compared with the configuration of drawing 11 , the back focus length of a projector lens 64 needs to make the configuration of drawing 12 longer than the back focus of the projector lens 64 of drawing 11 . Also in the projection device of the light valve of three plates, like the case of the veneer, a contrast ratio can be raised or color nonuniformity and illuminance nonuniformity can be reduced.

[0056] Drawing 14 is drawing for explaining the configuration of the aligner by this invention, and, as for a reticle and 73, the homogeneity lighting system corresponding to either claim 9 thru/or claim 20 in 71 and 72 are [a projection lens and 74] substrate stages among drawing. The aligner of this invention illuminates a reticle 72 with the homogeneity illumination-light study equipment 71 of a publication to either from claim 9 to claim 20, and is exposed by the wafer with which the pattern of a reticle 72 was put on the substrate stage 74 with the projection lens 73.

[0057] Drawing 15 is drawing for explaining the configuration of the laser beam machine by this invention, and, as for 75, a lens and 76 are work pieces among drawing. The laser beam machine of this invention condenses and processes the illumination light from homogeneity illumination-light study equipment according to claim 9 to 20 into a work piece 76 with a lens 75. The condensing spot configuration on a work piece 76 is the same as the aspect ratio of the irradiated section of an illumination system 71. Energy can be centralized on the minute part of a work piece by making it condense, and surface treatment, cutting, etc. can be performed. Moreover, since a lens 75 is transposed to a projection lens or homogeneity lighting can be carried out over the large range in the arrangement whose irradiated section is the direct work piece 76, it can use also as laser annealing.

[0058]

[Effect of the Invention] Also when it becomes possible to press down small the maximum incident angle to the section for lighting by according to the lighting system of this invention realizing compact optical system, Taira-Yukimitsu-izing the diffused light from this light source, and condensing by using two or more light sources and this applies to various applications so that clearly from the above explanation, the optical system of a good property can be obtain.

[0059] Moreover, according to the homogeneity lighting system of this invention, the lighting system in which simple and compact homogeneity lighting is possible can be obtained by having the above-mentioned lighting system and a means to equalize luminous-intensity distribution.

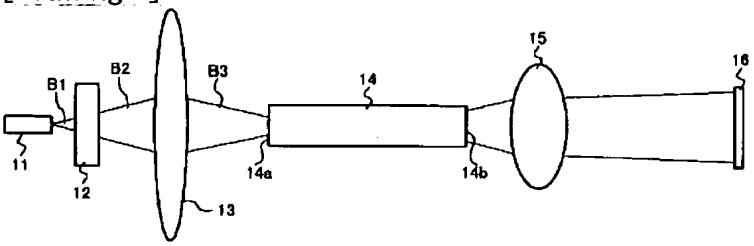
[0060] Moreover, a quality and compact projection device, an aligner, laser-beam-machining equipment, etc. can be obtained like the above by using the lighting system in which homogeneity lighting is possible. For example, in a projection device, since the maximum incident angle to the light valve is reduced, the property about a contrast ratio, color nonuniformity, illuminance nonuniformity, etc. improves.

[Translation done.]

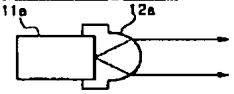
* NOTICES *

DRAWINGS

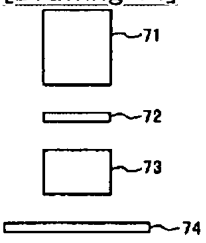
[Drawing 2]



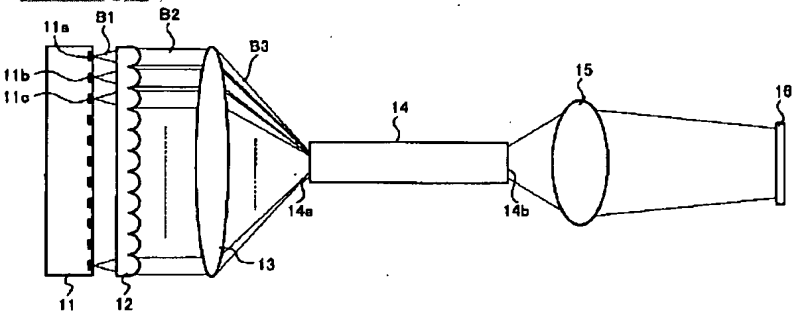
[Drawing 13]



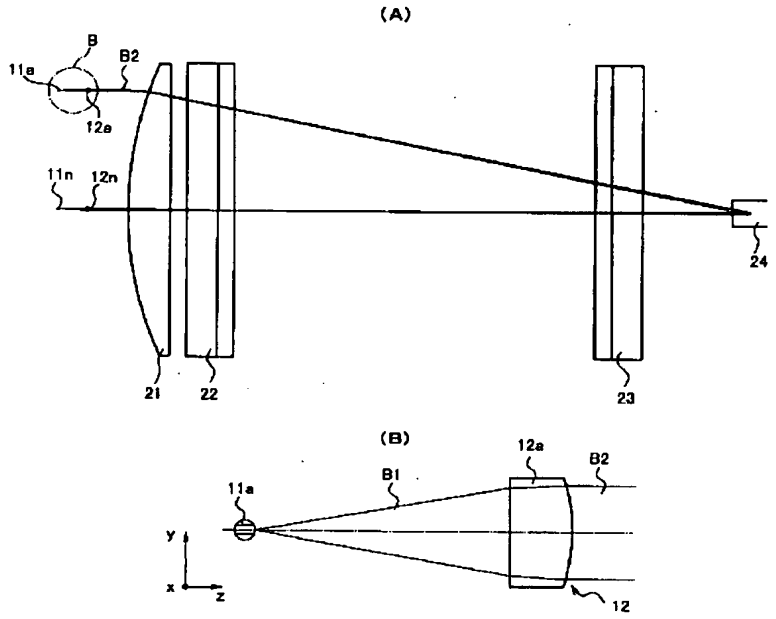
[Drawing 14]



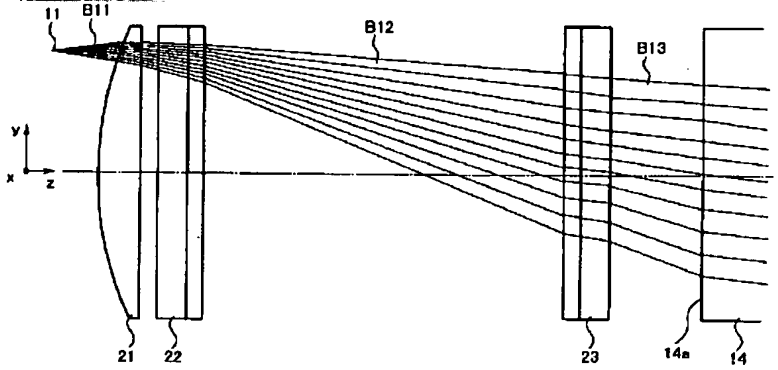
[Drawing 1]



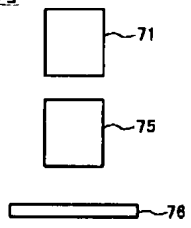
[Drawing 3]



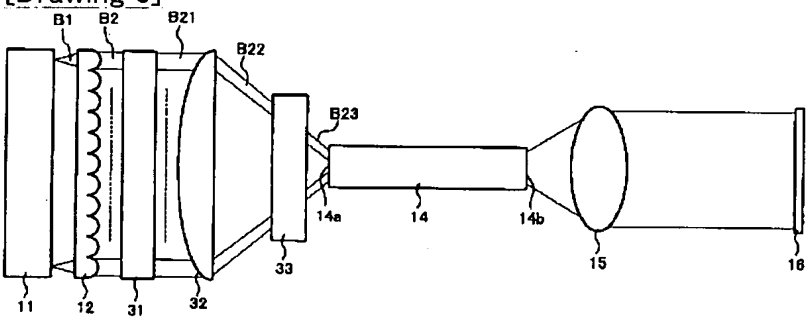
[Drawing 4]



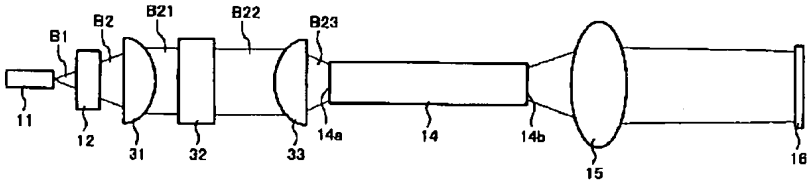
[Drawing 15]



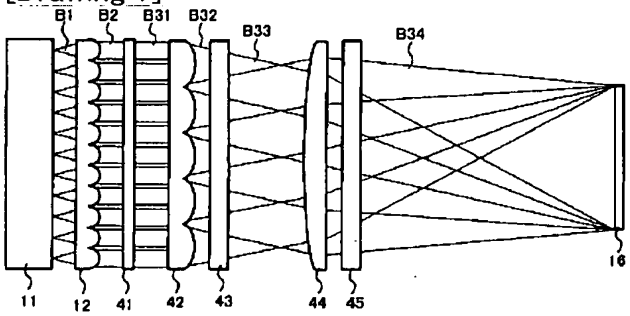
[Drawing 5]



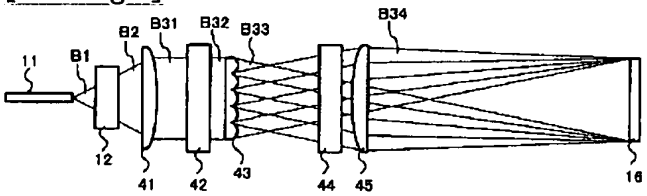
[Drawing 6]



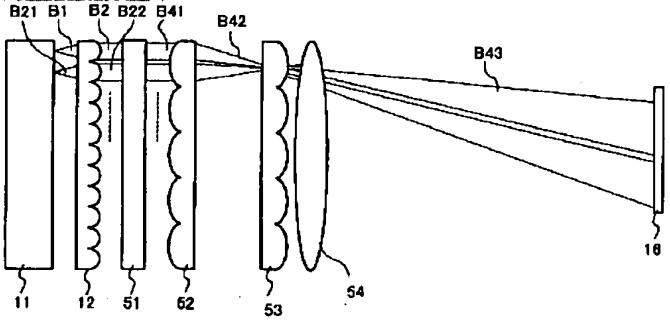
[Drawing 7]



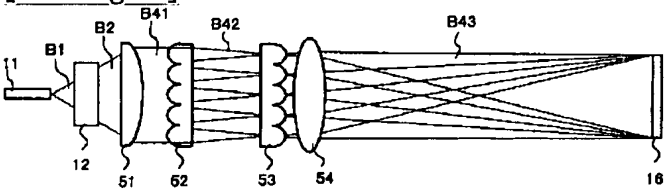
[Drawing 8]



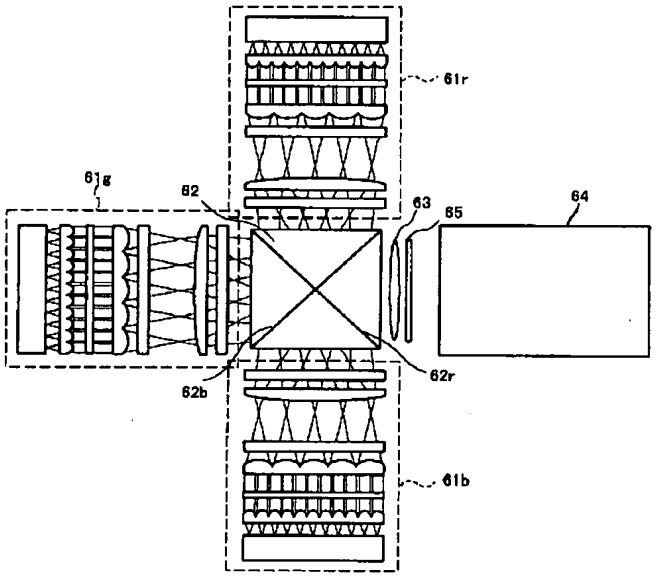
[Drawing 9]



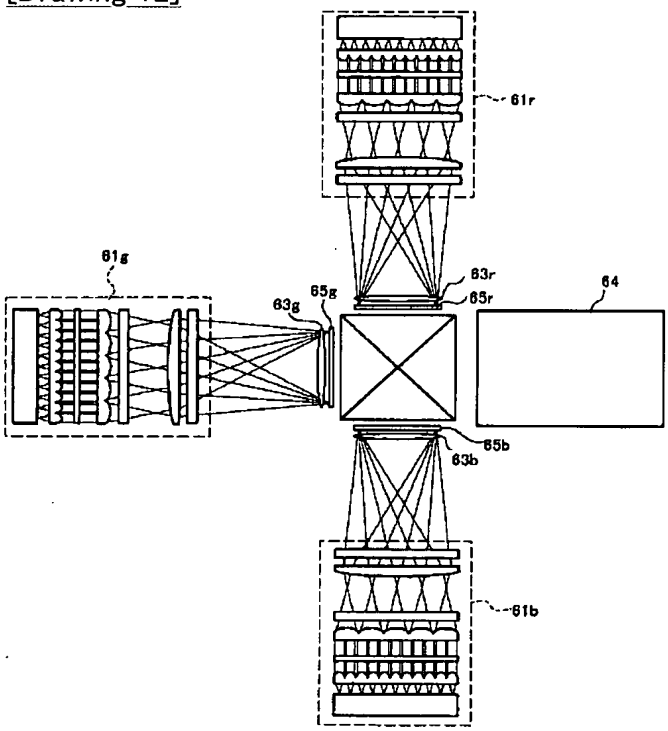
[Drawing 10]



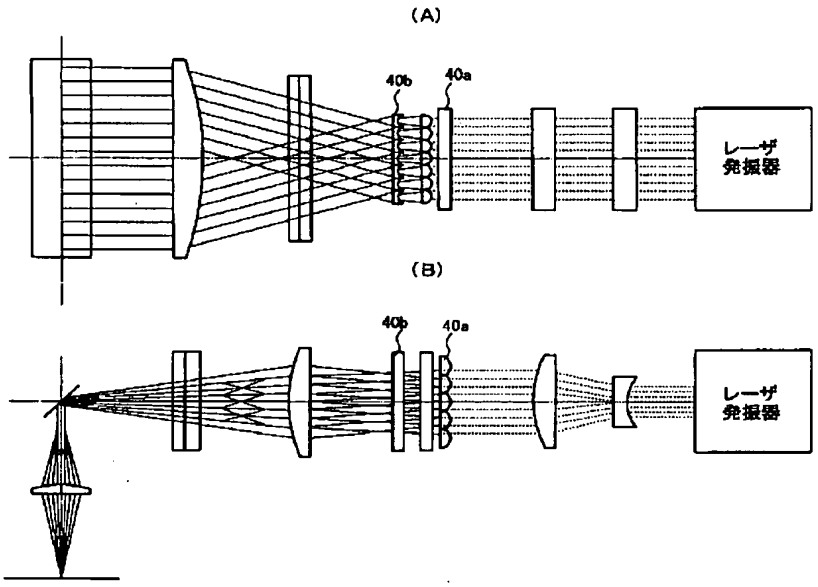
[Drawing 11]



[Drawing 12]



[Drawing 16]



[Translation done.]